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Mobility is more than a device: Understanding complexity in Health Care with ethnography

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This case study on mobility in health care demonstrates how ethnography and design research helped Intel meet the business challenge of redressing market share. Ethnography enabled the team to assess the interplay between mobile devices and other hospital technologies, understand how they fit within or subverted existing practices, and document positive and negative features of the technology. Our deliverables not only answered the direct business question, but also expanded the scope of possible solutions.

INTRODUCTION

Current state of health care transitions and the impact on the relevance of ethnographic methods

Throughout the world, health care is in a state of flux. New technologies have enabled lives to be saved and bodies to be mended in ways that were unimaginable only a few decades ago. Simultaneously, the influx of new technologies has created inefficiencies that frustrate clinicians and obstruct patient care. Research by Intel and others in health care has shown that when computing devices are not at the point-of-care (i.e. the patient's bedside), clinicians either resort to writing notes on paper and later entering the data in formal systems, or keeping this information in their heads until they are able to access a computer for data entry. Because of lack of point-of-care computing, clinicians walk up to five miles per day just to enter information into centralized computers (Shepley and Davies 2003) and spend up to a third of their day documenting patient information (Weigl et al. 2009; Hendrich et al. 2008).

In the complex and rapidly changing health care ecosystem, ethnographic methods are uniquely able to illuminate not just how individuals act, what motivates them, why and how they feel, but also how actors' interactions are shaped by the context. These interactions

offer additional insight into the complexities of health care environments when visualized and processed with user experience design tools that represent information symbolically, and take a holistic overview on the studied phenomena. This helps to build an understanding which can inspire software solutions to some of the most common pitfalls regarding information communication and storage.

New health care phenomena: The motivations for the project

The rapid adoption of mobile devices, in particular, consumer-oriented tablets and smartphones, by health care practitioners in clinical settings was a driving force behind the research we describe in this paper. In their personal lives, health professionals were having positive experiences with computing devices, such as access to information when and where needed, apps to help with specific tasks and simple usages like capturing images and voice for professional usage. It seems natural that they would start to import their experiences from the personal to the professional setting.

Industry reports and other studies conducted by Intel[1] in health care settings showed that the easy mobility people were experiencing as private consumers was not being matched in most clinical settings, especially hospitals, where stationary workstations were the norm. "Mobility" was still being defined as a computer atop a cumbersome, heavy, purpose-built cart, appropriately called a COW (computer on wheels). Even ultra-mobile clinicians, such as home health providers, were relying on laptops that were heavy, slow, and short on battery life.

The size of popular consumer tablets is well-suited to health care environments. They approximate the size of a paper patient chart, have a well-developed ecosystem of applications, a handy user interface (particularly the iPad), and industry-leading battery life. A significant portion of tablet uptake was being driven by doctors who were bringing their own devices into hospitals. Intel clients began reporting that the Bring Your Own Device (BYOD) phenomenon was taxing hospital IT management resources and creating concerns about information security.

To understand the roles that these consumer devices were playing in the clinical environment in the midst of their rapid uptake, Intel sought to build a strategy to refresh an understanding of clinician values balanced against infrastructure needs of hospitals, and to design solutions that would work for health care professionals and their environments. Key issues included how new devices were addressing (or not) known issues around security, manageability, infection control, and interaction with legacy systems.

OBJECTIVES AND PREPARATIONS

The project impetus came from Intel's Health Strategy and Solutions (HSS) group, an internal organization focused on clinical applications of technology. The plan included three strategic components: go-to-market, user experience, and incubation of new ideas to reinvigorate Intel's role in the health care market. The study objectives were to investigate

[1] Proprietary to Intel.

current behaviors and contexts around mobility in the health care system, and to understand how to best implement the new but unproven Windows 8 operating system on tablets in the predominantly Windows health care sector. To supplement this research, the Intel team compiled existing internal research on clinician workflows and technology needs.

The Intel project team was headed by TH, an expert cultural anthropologist, experienced in leading large-scale, international ethnographic and design studies. NV, a medical anthropologist on the HSS team, provided contextual expertise. Because of the large scope and tight timeframe of the project, it was evident from the start that Intel would need to engage consultants in order to conduct the research within the required timeframe. The consultancy selected was Experientia - a globally operating user experience design consultancy, with experience in the health care field.

During the kick off meeting between Intel and Experientia, the team members presented their expertise and priorities in an upfront and transparent manner. Possible scenarios and alternative plans were outlined in case certain methodologies did not fit within the research framework. Finally, the meeting allowed for all team members to clarify their expectations regarding the project goals. The benefit of this carefully curated kick-off meeting was a feeling of team cohesiveness and mutual respect that set the tone for the entire project. This kind of chemistry also involves luck, of course, but can be fostered by building time into projects to create understanding and shared perspectives. For this project, it allowed a strong consensus on methodology, which became one of the key strengths of the project, and later developed into a continued environment of open sharing between the research teams and the design and engineering teams.

UNDERSTANDING THE EMOTIONAL CONTEXTS OF HEALTH CARE: METHODOLOGY

From the start, Experientia and Intel agreed that it was important that the methodology explore the emotional aspects of health care professionals' work. The team was aware that hospitals are necessarily bureaucratic, and that the nuances of "caring for ill people" can frequently be overlooked in exploring something as seemingly procedural as how technology facilitates workflows.

The research objective was therefore deliberately described in a broad way ("How are the technologies being used at hospitals?"), so that the health care environment could be explored far beyond the digital reality. In addition, a flexible approach to the fieldwork structure and the broad scope of final deliverables made it possible for both research and design paths to freely develop and coexist.

The Balancing act of Anthropology in the hospital environment

The methods traditionally applied by anthropologists in the medical context have been challenged by many social scientists. As Long states "particularly with regard to pain and suffering, we [anthropologists] should be cautious and critical towards our achievements," (Long et al. 2008:75).

Anthropologists need to be aware of the limitations of their practice inside hospitals, how the presence of "researchers" influences this environment and how it impacts the idea of participatory observation taking place in the field. Considering these limitations, the team ensured a highly flexible and open research framework, adapting activities to accommodate such things as participant schedules and requirements. This created a fertile research ground, which was able to avoid roadblocks that might have otherwise impacted the quality of the research. To again quote Long, "The power of ethnography lies in its modesty and awareness of the incompleteness," (Long et al. 2008:75).

In an influential book "Technology and Medical Practice" (Heath et al. 2003), Christian Heath emphasized that anthropological research in health care should concentrate on (a) the influence of 'local culture' surrounding the usage of technology, (b) practical circumstances of the environment and (c) the prominence of objects and artifacts in conducting and influencing medical interactions. It must do this despite methodological challenges posed by an unpredictable environment, with fluctuating timeframes and tasks, and while remaining sensitive to the nature of patient care and privacy.

Exploring which elements impact the environment — The research covered a broad spectrum of what creates the context itself. It focused on the aspects described by Heath - local health care culture(s), specific hospital environments and person-device-person interactions. Motivated by Intel's specific desire to understand the niche for future devices or services, it also explored the usability of the technology itself. While the look and feel of a specific device influences the doctor-patient interaction, its technical functions and physical portability are important in storing and conveying doctors' expertise. In other words, the technology becomes an extension of the doctoring profession and a representation of doctors' knowledge. Trust towards technology is crucial for doctors to efficiently delegate some of their daily tasks to an external device (Future of Health care, O'Reilly webinar, 2013). The higher the reliability of the tool, the smoother the transmission of knowledge and the lower the user's learning curve. The reliability of tools when doctors are mobile inside the hospital, the circulation of information, people, objects, and devices in the system, and solutions to support these, constituted important aspects of the research environment.

The research aimed at exploring transnational phenomena, exploring the hospital environments in four countries - China, US, UK and Germany - through extensive observation sessions in the hospital, including morning rounds; practitioner interviews, simple observation in public spaces; and highly immersive participatory design sessions in each of the locations. The research was kept significantly flexible. Nevertheless, hospital regulations vary among countries, which can result in less structurally coherent research across contexts. Considering ethnographic fieldwork as an "open-ended emergent learning process" which is highly creative and flexible (Whitehead 2005) and which aims to discover a "non-constant" culture, such complexities are a natural outcome and are an important insight into the broader culture of the studied environment.

In this respect, collaboration with the health care professionals was an important part of navigating the numerous encounters and interactions of the complex hospital environment. Bardram describes collaboration as an important aspect of the hospital per se, because it influences doctors' workflow, mobility and efficiency (Bardram and Bossen 2005). In fact,

the complexities encountered in designing and conducting the research reflected the complexities of the hospital environment itself, creating a commonality between the doctors' and the ethnographers' experiences: "Collaborative work is enacted in space as well as in time, which becomes significant on close analysis of what takes place," (Bardram and Bossen 2005:158). This reflection became a prevalent aspect of both the fieldwork and analysis phases.

Immersion within the environment, to the extent allowed by the institutions and in a way following and inspiring participant engagement, helped to gather findings that touch upon the broader cultural context, specific hospital environments, the role the existing hospital technology plays in the hospital interactions and its usability. However, the complexities of the hospital environment involve an additional aspect, which transcends the functional completion of daily tasks: this is the element at the heart of the experience –the patient.

Exploring which elements impact patient care — The nature of hospital life, with particular regards to ethnographic research, has been described as representing "a condensation and intensification of life in general," (Long et al. 2008:73). Health care environments require additional sensitivity from researchers, as the focus of medical environments – providing care – also needs to become an undisputable priority for the research teams. "It is a delicate relationship [between anthropology and health care] requiring much sensitive nurturing," (Long et al. 2008:71). Some academics believe that, due to medicine's strong ethical and power significance, providing care becomes part of an immaterial environment - similar, for example, to religion - that should be kept outside of the "simple", mundane world (Foucault 1971; Miller 2005). These two realities - regular and immaterial - do not theoretically intermingle and collide, making it difficult for researchers without a medical background to enter hospitals, or, if they do, to make sense of it. Getting adequately ready for the field research and being equipped with tools that can trigger abstract/creative thinking among the participants can help both the UX professionals and those responsible for implementing technologies in hospitals build an accurate understanding of how the material reality can support the "immaterial" layer of the hospital and vice versa.

Building this kind of intricate understanding is difficult in a context that requires a lot of time for sense-making for outsiders. This is particularly true in the commercial world, where short timelines do not provide corporate UX researchers with an opportunity to immerse themselves in the context the way that academics would. To overcome this barrier, the team conducted extensive desk research preceding the fieldwork, equipping them with necessary knowledge of the environment. The researchers, with this preliminary knowledge of the situations they were immersed in, had the opportunity to become valuable conversation partners for the doctors, IT professionals and the medical body as a whole. They were able to "reflect in action" (Schön 1983) - consciously modifying the fieldwork priorities on the spot and not missing any important threads for the person at the focus of the research. This recognized that providing care is not just about the systems and tools in use. It is also – or even mainly - about discovering the emotional states of health care professionals in their

work contexts, and their opportunity to feel that their opinions are respected and their views are heard with empathy and understanding.

This combination of exploring environmental factors while acknowledging people factors created a well-rounded research approach. The two pillars of collaboration with professionals and the immaterial layer of the hospital formed a solid basis for understanding how devices could support health care professionals in their work tasks, both functionally and emotionally. Nevertheless, it was only with the support of participatory design tools that the ethnographers could discover what was invisible to an observing research eye.

Triggering Creativity: Tools used during the research and design

Selecting effective tools for research — The decision to use participatory design tools stemmed from the shared belief that professionals practicing in such complex and dynamic environments possessed tacit knowledge not easily acquired solely through ethnography. Prompted by ethnographic inquiry, medical professionals could speak about their daily tasks and responsibilities, and contextual observations would yield researchers' own takes on what these responsibilities implied. However, the personal tacit knowledge, a dense invisible layer swirling through the medical environments, could not be easily transmitted to researchers through speech or text. It was hypothesized that this knowledge could be discovered – and somehow recorded – by engaging medical professionals in doing and in playing (Greenbaum and Kyng 1991). The combination of methods ensured that the team accessed the subjective realities of doctors through participatory design, and anchored it with the objectivity of the other ethnographic methods.

Admittedly, the combination of in-depth desk research, contextual inquiry and environmental observations, and cooperative sense-making activities is a common professional practice. Yet it is the cross-pollination and effective joint application of these methodologies that gets to the heart of designing for the future and not for the now. In tight timeframes, it is tempting to sacrifice a research component to save time, but in this case the team was in firm agreement that each component was critical to the success of the project, and that the ethnography and participatory recipe emphasized "the content, not the chrome" (Bassett and Partners 2012). The team agreed that people's future interactions with technology do not merely lie in competitive device-wars, but in providing user-centered services which are self-sustaining and adaptable. Understanding real-world practice to design an effective work-oriented tool (Ehn 1990) that doctors can actually trust is vital to not only compete but lead.

Through Intel's previous research, researchers and designers were aware of the alternative solutions that physicians resort to as a result of computing devices away from points of care (e.g. transcribing information on paper to later transfer to patients' EMRs). But the emotions connected to these workarounds were still unknown. Comprehending the emotional effects of technological interactions would help the team determine which emotions to foster and which ones to avoid within future mobile point of care devices.

Unlike designing user flows for other environments, health care – which involves multiple inputs and outputs – requires thinking "more about patterns of desired outcomes and behaviors [...] rather than just moving the user through one flow or one experience"

(Basset and Partners [video] 2012). Experientia therefore considered medical professionals' journeys as similar to user-centered customer journeys, in which the user touchpoints are health care interaction points, procedures and operating parameters.

The participatory workshop activities were designed to try and grasp the beyond-the-obvious interaction points, and particularly how physicians would like to interact with them during their day. Additionally, the aim was to obtain artifacts that captured the emotional perspective and were also comparable cross-country and cross-institution. It was further believed that engaging participants in visualization exercises of their daily experience, with definitive markers (or touchpoints), would be a guiding force in designing a solution to fit inside existing habits and workflows – not replace them. The participatory design protocol placed great emphasis on visual engagement, carefully flowing from more direct and rational activities to more abstract and emotionally engaging ones.

The finalization of workshop activities was greatly nurtured by referencing servicedesigntools.org, an expertise sharing platform. There, researchers found a gamified customer journey mapping activity originally designed for a transportation project (Kahn and Tallec 2011). A common roadblock within the participatory design field, and within the emerging field of service design, is the difficulty of finding useful information on employed methodologies. Practitioners have been focused on 'doing' rather than transcribing (Slocum 2003) their process and are sometimes also bound from sharing their knowledge and expertise by organizational and business policies. However, accessing such resources provides great value both from an expertise point of view as well as a financial one: to find the right approach might have taken researchers additional time, which translates to billable hours. In the design of mobile interactions, tightening the collaborative weave between diverse fields and even organizations can be beneficial to both the development of responsive services and the evolution of participatory and service design fields.

Although the original context of the activity differed, the customer journey roadmap was adapted to the health care context. Its inherently strong visual components created a common language between researchers, designers and health care professionals that transcended individual unsystematic and unquantifiable experiences *and* rendered the walled intricacies of the health care environment clear to the foreign spectator. The hospital journey activity also created a common language in which to synthesize information amongst the four countries, as words were replaced by icons.

Initially, participants were subtly encouraged to individually express feelings towards their varied hospital experiences and interactions by linking touchpoints to the emotions they generated. In later phases of the activity, they were encouraged to share these experiences with the group, revealing a plethora of previously unmentioned (or possibly unknown) mental states. The activity focused on the user as the primary, and most important, actor, and helped researchers and designers dissect the health care paradigm into smaller, more manageable human-scaled, empathy-building experiences. Activity results not only verified Intel's previous research but also expanded upon them as participants were not limited to speaking solely about technology– rather technology and the devices used during their day (not only at work) were represented as facets of people's multi-dimensional experiences. Notably, shifting attention to daily intra- and inter-personal interactions and the mapping of people, technologies and emotions in this context provided valuable input with

regards to the larger hospital network, creating clarity into how disparate hospital spokes intersected to create a connected and pulsating hub.

Another workshop activity was based on Buxton's "Wizard of Oz" principles (Buxton 2007). Participants were asked to role-play a typical health care interaction, such as between a doctor and patient, and describe how an ideal mobile point of care device could transform this experience. The device was also part of the role-play, personified by one of the participants themselves. The role-play adhered to Buxton's principles: 1. It is fidelity of the experience, not the fidelity of the [...] technology that is important from the perspective of ideation and early design, and 2. We can use anything that we want to conjure up such experiences (Buxton 2007:239).

Activity results explicitly demonstrated physicians' needs, as there were no qualms involved when they were delegating requests or asking for information from a device. Researchers discovered that physicians, above all else, longed to trust a digital tool, but were reluctant to, because of previous experiences with device and service discontinuity. This shows how vital trusted interaction with a tool is to specialists who must delegate their expertise to a non-human device. A key take-away for designers was to design flows that built trust and confidence, beyond merely fulfilling orders.

Transferring Insights from Researchers to Designers and Engineers — The principles used to design the final digital deliverable were based around 5 emergent research themes, encapsulating the four countries' insights. These were presented by the research and analysis team to Intel's extended research, engineering and design team. However, designing a responsive and quickly adaptive interaction flow required the designers to have a clear understanding of all of the possible physician interactions, which goes beyond a mere outlining of research themes and findings.

To fully visualize all the players in the system, and the relevant back-end (software and programming) and front-end (interaction and user interface) challenges, a system blueprint was created, to translate across disciplinary language boundaries and create transparency between all involved teams. This common visual tool led to transdisciplinarity – the point where field-specific boundaries are surpassed so that sharing, teaching and learning happen freely (van Zyl 2007). Iterative workshops involving Intel's engineers presented researchers and designers with empathy building and knowledge sharing opportunities regarding each group's vested interests. In cases where designers needed a medical consultant, physicians from Experientia's and Intel's extended professional networks, as well as researchers who had participated in fieldwork, became important points of reference. In this way, the interaction flows that began to emerge from the design phase were reactive and "alive", and even offered additional offline touchpoints to complement the service system.

Bardram and Bossen (2005) describes four factors that influence the need for doctor mobility: necessity of using shared resources, being in specific places, accessing knowledge, and being in contact with specific people. By integrating this kind of information, we conducted an additional analysis of doctors' daily lives, with all the people, objects, places, devices, tasks, roles, activities and emotions present in their daily routine combined. In the "day in the life" analysis we saw how far away from regular routine the doctors' days are and how little time is given to their "immaterial" task in an uninterrupted way - providing care.

The ultimate translation of the data into design solutions followed a close collaboration between researchers and designers. The team delivered a "thick" video prototype of a possible service proposition that responded to doctors' multiple roles, tasks and environments and coexisted with the devices already present in the institution. The concept acknowledged all the present constraints in the American health care system (as the context most immediately relevant to Intel) and represented a solution that is close to "here and now", rather than situated in a distant future.

The final deliverable was also informed by the stakeholder and business challenges encountered by ethnographers in the field. Being present during actual medical procedures and observing situations involving drug administering protocols and the reverberations felt by physicians and billing/pharmacy departments, helped to create a realistic model for the digital tool. The final design incorporated interactive flows that were not merely dreamy best-case scenarios, but responded to the nitty-gritty inherent problems within the business of health care. This reinforced trust in the tool and exemplified how user-centered development could trigger the development of other supportive technologies.

RESEARCH DISCUSSION

In this section, we share several insights which we feel are fundamental to understanding the value of this project (without sharing Intel's proprietary outcomes from the research). We also draw conclusions about the fit between the methodology chosen and the research environment. While the research insights can only be applied to highly specific interactions, the methodology conclusions are applicable to any kind of research happening in health care institutions, and possibly extendable to other similar contexts in which privacy, professional secrecy and particular sensitivities create a strongly closed research environment.

Research insights

Long (Long et al. 2008) calls for the use of anthropological insight for a broad range of people involved in the environment, including nurses, health managers, allied clinicians, patients' families and support groups. Doctor and patient experience is impacted on, to various degrees, by all players. A holistic picture can only be created if these roles are also included in the research to some extent. Our team employed methodologies that revealed the context of use of all the agents involved - including systems, people, technologies and tools. What we discovered was a lack of common ground where all these intermediaries could interact and support the doctors in fulfilling their tasks and the patients in undergoing their treatments. Through confronting information coming from observation, interviews and participatory design activities, we could grasp these inconsistencies and the amount of double work they cause.

We discovered that inconsistencies, duplications and redundant steps in the workflow strongly impact the clinicians' performance at work and cause disruptions to the time they should be spending with their patients. The number of technologies implemented in health care causes "invisible work" (Nardi and Engeström 1999) and effort to users and - usually -

resistance towards further adoption. New technology solutions often do not give doctors proper access to the information they need, and implementation processes focus on establishing guidelines to address privacy and security concerns, which does not reflect doctors' needs when providing care. In addition, many electronic medical record systems were designed to facilitate tracking and billing of discrete services, and not to provide a holistic view of patient or population-based information.

This lack of effective access to patient information due to fragmented systems and ineffective mobile access is heightened by inefficient communication tools among the medical crew - making the information not only invisible but also untraceable. As a result, the doctors find the systems they must use unhelpful and sometimes unreliable, and often rely on their own tools and strategies to more effectively obtain the information they need.

Methodology Conclusions

UX research in hospitals is continuously increasing, as technologies used by doctors continue to proliferate. We found that medical practitioners were eager to talk about the more personal and emotional aspects of their work, but are rarely given the opportunity, as research conducted in hospitals often focuses on the technical and procedural elements of doctors' work. From the hospital administration perspective, this evolution of collaborative UX research and the medical domain is definitely beneficial, which still needs to be widely acknowledged. By providing access to their staff and systems, the institution can gain an external perspective on making health care services more efficient, and how and where to invest money in technological support.

In order to increase accessibility to the hospital environment and for collaboration between UX researchers and institutions to become more effective, ethical guidelines of what can and cannot be accessed during the research should be properly outlined, across cultures. Research that focuses on the efficiency of doctors' workflows and does not relate to medical diagnoses and treatment should be distinguished from other kinds of studies, and different accessibility rules could apply. During the described research, the researchers were confronted with a highly unsettled situation in one of the hospitals, which symbolized the insecurities of both the research participants and the institutions involved on what was expected from them. The idea of a "workshop" involving multiple members of staff at the same time was misinterpreted by the administrative body and led to a challenging situation for the researchers who had to tailor the activities to the new reality. Increased openness from all parties would surely help to alleviate and avoid these kinds of issues.

UX projects taking place in hospitals help to build a library of adequate research tools, learn more about the constraints of the environment, and discover ways of benefiting from its own limitations. A broad scope of methodologies applied by researchers in a constrained environment, including traditional ethnography and highly immersive participatory design sessions opens up possibilities for inspiration and encourages transdisciplinary solutions. Following Long, "As anthropologists increasingly gain access within hospitals, and as clinicians and health managers increasingly engage with ethnographers, we will continue to hone our tools for engaging in and applying ethnography in hospitals," (Long et al. 2008:76).

IMPLEMENTATION OF THE INSIGHTS INTO INTEL'S PROCESSES

Data from this study kick-started an mHealth incubation process aimed at creating and prototyping new solutions for health care. Incubation efforts (at Intel/HSS) standardly apply a model that combines expertise/information from Business, User and Technology perspectives (BUT model). Whereas the "B" or the "T" often predominates in the incubation process, in mHealth, the wealth of information available from the user perspective meant that the "U" led and remained a dominant force in the identification, the filtering, and the development of incubation projects. The user needs and contexts identified from the data are the yardstick for measuring the incubation concept as it moves through prototyping, validation and piloting.

Internally, Intel has used data from the study to influence the work of business units that are not usually involved in health care. In some cases, this has spurred incubation of new product concepts. In others, this information has given business units new users and usages for their devices, features and products. In still other cases, it has highlighted the complex requirements of clinicians, ensuring that they are included in feature roadmaps. Ultimately, the project has also become exemplary for how ethnographic insight can be used to generate use cases and technical requirements.

Business relationship managers and Business Development Managers (BDMs) have been able to use insights from the study to build "trusted advisor" status with health care customers while at the same time helping to document a willingness to participate in future studies. User stories help them demonstrate the company's awareness of the health care environment, as well as the back-end needs of enterprise-level IT environments. Go-to-market sales activities use these stories to demonstrate how existing products can meet individual and enterprise needs. The Intel team continues to mine the study data for new insights.

NEXT STEPS

While innovation in health care involves creation of devices that are both enterprise and user friendly, and which meet the specific needs and demands of clinical end users, innovation does not involve devices alone. Innovation involves holistic implementation of technologies and services so that clinicians can focus on the patient and on providing care. This must also support analytics that allow clinicians to rapidly make sense of multiple, single patient data inputs as well as massive population-based databases. Medical analytics are a clear opportunity space, but at present are hampered by conflicting technical and social standards.

Holistic implementation needs to acknowledge two main things. The first is that hospital environments cannot be boiled down to technical workflows - because they deal with something as emotional as people and patient care, research and resulting solutions must take that aspect into account. This can be achieved by carefully crafting research methodology, preparing the researchers for the challenges posed by the "immateriality" of the medical context and by close collaboration between the researchers and the designers.

Secondly, because workflows are incredibly complex, UX has to take a hospital-wide approach. "Tacking on" a device to an existing system has previously resulted in bloated and inconsistent frameworks. At the same time, if development focuses on creating a device to solve all problems, without taking into consideration existing technologies and existing workflows, the device is bound to fail. The challenge for UX design is to bridge existing fragmented solutions into something more coherent (so that billing and patient care are not in conflict, for example), without simply add new modules onto existing and inefficient systems. Extending the UX knowledge database through extensive desk research before departing for the field is crucial to facilitating the creation of a realistic final concept that fits into the existing ecosystem of the hospital.

In this project, combining ethnographic and design research enabled the team to create actionable outputs - personas, day in the life, opportunity maps - that make the results actionable for a broad audience of stakeholders across Intel. This is a key step in creating innovation that fully addresses research insights, and has complete buy-in not just from the hospital stakeholders, but also from all the people within the design process. This buy-in is a strength of the project, and in turn, strengthens the process, making user research, design and engineering into a truly integrated process, with fully aligned approaches.

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